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ANNUAL REPORT 1940

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ABRIDGED REPORT

ON THE WORK IN 1940 OF

THE RUBBER RESEARCH INSTITUTE OF MALAYA

BY

THE DIRECTOR

The Annual Report of this Institute has grown progressively larger in recent years. Although this is partly an indication of a progressive expansion and development of the work of the Institute it was evident that the Report was becoming too big and unwieldy, and after the publication of the Report for 1939, it was obviously necessary to make some change in the method of presentation. It was intended, in any case, to make the Report for 1940 relatively short and to publish separately much of the detail hitherto included in the reports of the Divisions. Since then, as a result of paper shortage, paper control has been introduced, so that we must now make a virtue of necessity and perforce cut down the size of this report even further than originally contemplated. This is the more necessary, even beyond the strict requirements of the Paper Control Order, in order to husband our existing stocks of paper, since the shortage may become even worse. This year, therefore, all that is being issued indiscriminately to everybody on our mailing lists is an Abridged Report., consisting of the Director's Report in a shortened form, including tables of contents and summaries or extracts of the Reports of Divisions, etc. However, the full Reports of Divisions, of the Experiment Station, of the Small Holders' Advisory Service and of the Board; and detailed information included in former years in the Director's Report, which are not now included in this Abridged Report, are all being separately printed and may be obtained (in whole or in sections) on request. They will, also, always be available for reference at the Institute. It is regretted that, as a result of delays arising from the War, this Report is late in appearing.

Only a strictly limited number of these detailed reports are being printed. This number includes a certain reserve for use in dealing with special enquiries, but the total number actually printed will depend on how many copies are asked for by recipients of this Abridged Report, within two weeks of its issue. Perforated detachable sheets will be found at the end of this Abridged Report. All readers wishing to receive any of the detailed Reports must fill up these sheets accordingly and return them to the Institute immediately. If this is not done, copies of the detailed Report which are asked for later may not be available.

Members of the Board

During the year, following the expiry of the term of office of several members of the Board, Mr. W. E. Wallis, Mr. R. Heywood, and Che Mahmud bin Mat became members in place of Messrs. A. P. Cranna and J. R. Barton, and Che Hamzah bin Abdullah respectively; Mr. D. Farquharson similarly became a member of the Permanent Committee in place of Mr. A. P. Cranna.

Work Retarded by Military Service

The most important effect of the war on the Institute was that resulting from the compulsory embodiment, for two months, of the European staff of military age (under 41) and of Asiatic Volunteers. Altogether, fourteen members of the European staff, out of twenty-two, and five members of the Asiatic staff were absent, each for this two-month embodiment period. The effect of this was to hinder the work of the Institute by an amount appreciably greater than that

corresponding to the actual amount of time absent on embodiment, and this effect was greatest in relation to the research and experimental work: owing to the simultaneous embodiment of much of the European staff on estates, the volume of requests for advice during the embodiment period was less. Apart from this interference with the work of the Institute, there were relatively few special war problems to cause diversion from the normal programme, which continued as already laid down. Difficulties in supplies of chemicals, however, seriously interfered with work on the control of soil pests.

Permissible Exports and Prices of Rubber

Nineteen hundred and thirty-nine had already been a prosperous year for the Malayan rubber industry, and 1940 was even more so, since it combined a high rate of release by the International Rubber Regulation Committee, with high prices. The percentage of the Basic Quota which was permitted to be exported rose throughout the year, from 80 per cent for the first two quarters to 85 per cent for the third quarter, and 90 per cent for the fourth. The corresponding domestic releases were 80, 77½, 82½, and 90 per cent, with an average for the year of 82½ per cent. The price of No. 1 X Ribbed Smoked Sheet in Singapore varied between comparatively narrow limits, the lowest figure for the year being 35⅝ cents, and the highest 39¾ cents, with an average of 37.55 cents per pound.

Expenditure and Income

The total expenditure (excluding depreciation, which is not provided for in the estimates) was $814,000, an increase of about $116,000 over the figure for 1939. Much of this increase was a result of increased costs arising directly from the war; much was also due to the fact that the expenditure at the Experiment Station necessarily increases steadily from year to year with the opening of new areas and the coming into tapping of others. A large part of this increased expenditure at the Experiment Station consists not of expenditure on experimental work bringing in no cash return *to the Institute,* but of revenue-producing expenditure identical in character with that incurred on an ordinary commercial estate. Such revenue-producing expenditure, under present conditions, brings in a very good return, and this is well shown by the fact that the increase in the income from the sales of rubber produced at the Experiment Station was $70,000 over that for 1939. A result of this, and of the fact that the income from the same source for 1939 proved to be $30,000 more than the estimates for that year, is that, in spite of the increased total expenditure, the 1940 contribution from the Malayan rubber producing industry, by way of the Malayan Rubber Fund, at $540,000, was over $100,000 less than in 1939.

Staff Movements and Work

There were three losses from the Senior staff in 1940, one by the much-lamented death of the Manager of the Experiment Station, and two by resignation; and two gains, being new appointments to fill the vacancies caused by these resignations. Seven European officers were on long leave for varying times (excluding leave following resignation). The number of Senior staff (Research Officers, Secretary, and European staff at the Experiment Station) at the end of the year was 22; the effective number of Research Officers on duty as an average figure for the year, was 16½, disregarding absence during embodiment, or 14 when such absence is taken into account. Seven members of the Junior staff left the service of the Institute and eighteen appointments were made (including six Asiatic Rubber Instructors), three of which were from daily-paid workers already employed by the Institute. The number of Junior staff at the end of

the year, including 36 Asiatic Rubber Instructors, but excluding men on daily rates of pay, was 190. The number of employees on daily rates of pay, on the 31st December 1940, was 25 at Headquarters (including Small Holdings) and 342 at the Experiment Station. The total number of employees of all grades at the end of the year was thus 579.

The Staff Committee met seven times during the year.

The relative amount of time spent by scientific officers, on research and experimental work, and on advisory work, remained much the same as in previous years, namely about two-thirds and one-third, though the proportion of advisory work in the Chemical Division was higher than normal as a result of special problems arising from the war. Further comment on this, beyond that made in the 1939 Report, is unnecessary.

Once more, as a result of the embodiment of the Volunteers, the projected Planters' Conference had to be postponed. The number of lectures was also less for similar reasons.

Publications

Publications consisted of six numbers of the R.R.I. Planters' Bulletin, nine Communications of the Journal, three printed Circulars, the Annual Report for 1939, and the much-overdue new edition of Planting Manual No. 6 on the "Uses and Control of Natural Undergrowth on Rubber Estates."

During the year 72 books, excluding pamphlets and periodicals, were added to the Library.

Visitors

The Visitors Book records 608 visitors in the year (in comparison with 861 in 1939). Together with 311 visitors to the Experiment Station, the total for the year is 919. Included in these were 32 visitors from outside Malaya. Co-operation with related departments and bodies continued as in previous years, and in many cases it was closer and more frequent than formerly as a result of problems arising out of the war, particularly in connection with supplies of chemicals and fertilizers.

Staff

It is doubly pleasant to be able to acknowledge the steady and loyal support which I have received from all my staff, under these abnormal war conditions, though we are fortunate to have suffered in this respect so relatively little. Our sympathy goes out to our scientific colleagues in the rubber and in other industries who have not been so fortunate.

Small Holders' Advisory Service

At the beginning of 1940 there were 33 Asiatic Rubber Instructors; during the year six new Instructors were appointed. One resigned in October 1940 and two were not re-engaged on the termination of their first period of six years service with leave. At the end of the year 36 Instructors were employed in the Service. The employment of Demonstrators to assist A.R.Is. in the larger districts has now become an established feature of the scheme, and four more were engaged by A.R.Is. during the year, bringing the total to fifteen. With the increase in the number of Instructors it became increasingly difficult for the Small-Holders' Advisory Officer to visit each Instructor as often as is desirable. To overcome this difficulty a few of the senior Instructors have been detailed to visit and advise their juniors; at present these men continue their own work in the districts allotted to

them, but it may be desirable to appoint one or two "Superintendent Instructors" to supplement the general supervision of the Instructors' work in the various districts.

The question of provision of improved planting material for small-holders was further considered during the year, and arrangements were made to supply budwood of a number of first-class proprietary clones to small-holders. Budwood of these clones has been established in nurseries at the Agricultural Stations of the Department of Agriculture, S.S. & F.M.S. Towards the end of the year arrangements were made by Government to establish central multiplication nurseries up to a maximum of 200 acres to provide budwood for small-holders for use in replanting.

The Work of the Divisions

The records of **advisory and administrative work** of the Division, in comparison with previous years show that in spite of the war, or rather no doubt because the industry was working at full pressure as a result of the war, there was little difference between 1939 and 1940. The figures for visits and interviews and letters received per working day per Research Officer are: 1939—3.2; 1940—3.2. As a result of absences of staff during embodiment of the Volunteers, however, a greater proportion of the advisory work had to be done by way of correspondence and interviews at the Institute, and less of it by way of visits to estates. The total number of letters received at the Institute (exclusive of routine correspondence in connection with publications and Library matters) was 10,993, an average of 37 per working day. Visits to estates (excluding the Experiment Station and small holdings) numbered 779.

On the whole, the chief subjects about which enquiries were received, and their relative numbers were not very different from those for 1939 (see Annual Report 1939, page 30). Rather fewer enquiries regarding replanting were received by the Soils Division, but on the other hand a notable proportion of the enquiries received by the Botanical Division related to the choice of planting material for replanted areas. Abnormal conditions, arising out of the war, resulted in a considerable increase in the number of enquiries received by the Chemical Division in connection with coagulants (as a result of the scarcity of formic acid and the temporary shortage of other suitable acids), and smoke-houses (largely as a result of the marked falling-off in the latex market, so that many estates which formerly exported much or all of their output in the form of latex had to change over to the production of sheet).

As stated at the beginning of this Abridged Report, summaries of the main contents of the reports of Divisions, and of the Experiment Station, are given in the following pages, and the full reports may be obtained by separate request.

Research and Experimental Work: General

In the report of the work of the **Statistics Section** (See p. 18—Appendix to Director's Report), the Statistician records that analyses of data were carried out in connection with the results of 56 field experiments or laboratory investigations. Various sampling investigations were undertaken and much work was done on questions of experimental technique in connection with methods of recording yields from experiments, by plot and by individual trees. Sixteen visits to estates were made. Advice was given to research workers of other organisations. The Powers automatic computing installation was received and put into commission towards the end of the year. The designs of all the new experiments commenced in the field by the different Divisions, and of certain of the laboratory investigations, were prepared by or in consultation with the Statistician.

Co-operation with Cognate Research Organisations

Co-operation by way of visits and correspondence, with sister and allied research organisations, both in the East and in Europe, continued to the fullest extent possible under prevailing conditions; the following visits were made:—

By Messrs. Mann, Piddlesden and Owen to the laboratories of the London Advisory Committee; by Mr. Moore, to Agricultural Colleges and Experiment Stations in South Africa and at Canberra, and to the Proefstation Midden und Oost Java; and by Mr. Owen to Long Ashton and Rothamsted Research Stations, Harper Adams Agricultural College and Macaulay Research Institute.

As a result of the German invasion of Holland and France, our co-operation with the research organisations in those countries necessarily ceased.

The Conference of Directors of Rubber Research Organisations in the East, to which reference was made in the 1939 Report (page 35) was held at this Institute in February, and resulted in very valuable discussions and agreement regarding the bases for future co-operation. Unfortunately, owing to the war, such co-operation with our Dutch colleagues became more difficult, but it continued actively in spite of this.

Arrangements were made whereby the Institute assisted in effecting exchanges of proprietary clones between owners in Malaya and in the Netherland East Indies. The extension of exchanges to include new material developed by research organisations in the different countries was also considered at the Conference of Directors of Research referred to above.

SOILS PROBLEMS

The work of the Soils Division is summarised below under the same headings as those used in the Report of that Division (see page 18).

Soil Survey Work

Soil profiles on rubber estates and in jungle areas have been examined and sampled. A total of 118 profiles, involving about 10,000 analytical determinations on 669 samples, were examined during the year. Some progress was made in general mapping of soil types.

Manuring of Hevea

Results of experiments continue to confirm those of previous years, with phosphate the predominant need for young plants, especially on replanted areas, but second to nitrogen in importance for mature areas; and with potash producing results only on the lighter soils. Experiments on the making of compost, and its use, in comparison with inorganic manures and with dung, have been started both on mature rubber trees and on new plantings. A new experiment to compare different types of phosphatic manures, and the influence of calcareous materials on them, also a new replanting manuring experiment, have been started. In the experiment on manuring in the multiplication nursery, manuring three months before or after budding did not adversely affect the buddings.

Considerable attention has been devoted to peat soils on which the growth of young rubber trees was bad. Excessive amounts of tin were found in ailing plants; this was at first thought to account for the poor growth but later work suggests that the trouble is caused by toxicity of hydrogen sulphide under the reducing, waterlogged condition of the lower layers of the peat.

Severe bending of trees about three years old has been reported from a number of areas. There is nothing to suggest that manuring is concerned in this.

The total number of manuring experiments on estates, under the control or supervision of the Soils Division, is 110.

Cover Plants and Soil Management

Two new experiments in new clearings were started, one of which is an elaborate one, in co-operation with the scientific staff of two large groups of estates, to study the effects of different methods of clearing, and of different cover treatments, on the soil and on the growth of the rubber trees.

Results from other cover-crop experiments continue to be similar to those recorded for previous years.

The Division is supervising or controlling 15 cover-crop experiments.

Laboratory and Pot-culture Work

Reference is made to work on compost-making, on spectrographic analysis of young rubber plants, on leaf analysis, and on the phosphate status of Malayan soils.

BOTANICAL PROBLEMS

This summary of the report of the Botanical Division is arranged under the same headings as in the full report (See p. 18).

I. Vegetative Propagation

Methods of Propagation and Planting

Further experiments on the use of growth-promoting substances with budded stumps confirmed the conclusions stated in the Report for 1939 (page 45). There were rather more failures when manuring was done in the planting hole, as compared with manuring three or six months after planting, and the growth was no better. Growth-promoting substances did not improve the rooting of cuttings of cover plants except with woody cuttings of lamtoro. Early growth of germinated Hevea seedlings appeared to be stimulated by treatment with growth-promoting substances.

Stock-Scion Influences in Buddings

Seedling stocks from four families of clonal seedlings do not appear to possess any special merit as stocks for clone P.B. 186. Moreover, the growth of buddings of clones Tj. 1, Pilmoor B. 84 and PB 23 did not appear to be improved by buddings on illegitimate seedlings of the same clone. Vigour of growth of the stock, or the use of a stock of high potential yield, did not noticeably improve the growth or yield of buddings. On the other hand, there is good evidence of an effect of the scion on the stock. The vigour of growth of different clones was reflected in the growth of the stocks on which they were budded. Similarly, the yield of latex obtained from tapping the stocks below high buddings was positively related to the vigour of growth and the yielding capacity of the clones used.

Growth and Yields of Budded Trees

Further results of the experiments detailed in the *Annual Report* for 1939 (pages 94 to 96) are recorded. In the density-of-planting experiment (*Annual Report* 1939, pages 97 to 99) the plots planted at 222 trees per acre still give the highest yield, but the even more densely planted plots with 302 and 435 trees per acre have now nearly caught them up. The inferiority in the rate of girth increase, the more densely the plots are planted, has become very marked.

II. Tapping Investigations

Five new tapping experiments were started and three were terminated. Further results of the tapping experiments dealt with in the *Annual Report* for 1939 are presented. Chiefly, these may be summarised thus:—

Periodic ("A.B.C.") tapping shows progressively increasing benefit from the resting periods, which is greater with seedling trees than with young buddings, and greater for low-yielding than for high-yielding trees; and there are corresponding advantages in reduction of tapping cost. So far there is no significant difference between the benefits obtained with different resting periods varying from two months to six months.

On the whole, A.B.C. tapping has resulted in yields relatively little superior, on the area tapped, to those obtainable with continuous alternate-daily tapping on the whole area, so that the nett loss of crop is considerable, and much more than outweighs the advantage from saving in tapping cost.

In comparison with A.B.C. tapping, third-daily tapping on half spiral, or alternate-daily tapping on a third spiral have both given slightly better yields, with a saving in tapping cost in the first instance, but with an increase in the second.

Double-cut systems at 100% intensity show a slight advantage over the half-spiral alternate-daily system, but a much greater advantage is shown by **full-spiral fourth-daily tapping,** both on seedling and on budded trees. The latter system, however, results in a definite retardation of growth, which is greater with small than with large trees, and which is also the greater the higher the superiority in yield in comparison with the standard. However, if due precautions are taken, full-spiral tapping appears to have very pronounced practical advantages. A detailed presentation and discussion of the results of the experiments on this method of tapping has recently been published (Communication No. 254, J. Rubb. Res. Inst. Malaya) so that further discussion here is unnecessary.

The results with **daily periodic systems** (daily tapping on a half spiral for a month or other period followed by a rest for the same period) indicate only slight or no advantage in yield over the standard half-spiral alternate-daily system, with a tendency towards a somewhat lower growth rate. In one experiment, however, daily tapping for one month followed by rest for only half-a-month gave a marked increase in yield with only a slight retardation of growth.

The experiments on **slaughter-tapping** indicate that although a very great increase in yield can be obtained by using tapping systems of very high intensity over short periods, if these are continued for long the trees adapt themselves to the increased intensity, and the over-all increase in yield becomes comparatively small (*e.g.* about 20 per cent.)

A general study of the results from all the tapping experiments indicates that, regardless of the type of tapping cut employed, there is a close negative relation between yield and growth rate: systems of tapping giving the highest yield result in the greatest retardation of growth rate, and *vice versa.* This relation appears to be less marked in older trees than in young ones. Consequently, particularly with young buddings, growth records should be carefully kept, and the system of tapping used should be chosen so as to avoid serious retardation of growth.

III. Selection and Breeding

For the second year in succession the results of hand pollinations were very poor, the exceptionally dry weather in May and June again causing a considerable loss of fruits before they had matured. In October 23 families obtained from the 1938 hand pollinations were planted. New clones numbering 522 made from the 1938 hand pollinations were established, together with 37 new clones made from illegitimate seedlings at the Experiment Station.

Further yields from the seedlings derived from the 1928 to 1931 hand pollinations, and of the new "R.R.I. 500 series" clones derived from them, are given. The seedlings show a good increase in yield, which is particularly noticeable in certain families, notably B. 84 × G. 1. which now shows a yield of 13.5 lb.

per tree at an average age of 8 years and 2 months. A selection of ten of the new R.R.I. 500 series clones were offered for sale to estates, not for general commercial planting but for planting in small permanent trial plots. Supplies had been sent to 252 estates, totalling 3,900 yards of budwood, by the end of the year. The conditions of sale are similar to those for proprietary clones and the Board has decided to prohibit for the time being the export of these clones to countries outside Malaya.

The yields of several families of illegitimate seedlings are recorded. Many of these show satisfactory increases in yield; seedlings of P.B. 49 are outstanding. Yields of seedlings from the Tjikadoe and two other Isolated Seed Gardens are recorded. Considerable variation in the yields of the different families from each garden is apparent. From the Tjikadoe Garden the highest-yielding family gave an average of over 30 lb. per tree, which is about treble the yield of the lowest yielding family. Similarly in the families from the Batu Kawan seed garden the family from clone Prang Besar 23 yielded 64 per cent more than the lowest-yielding family derived from Prang Besar 186.

Further results in the study of the relation between early test-tapping results, and the yield actually obtained in normal tapping, are recorded. There is a still further fall in values of the correlation coefficients.

IV. Physiological Investigations

Nutrition

The study of growth and foliage characters of Hevea plants when grown in sand cultures in large pots has been continued (compare *Annual Report* 1939, page 141). Characteristic leaf symptoms for certain nutrient deficiencies have been in evidence. Certain of the plants were removed for examination and analysis. Records of the weights of leaves, shoots and roots excluding the original stumps were taken. Plants in the series where calcium was omitted from the nutrient mixture have made slightly better growth than those in the complete nutrient series. The striking effects of deficiency in phosphorus are amply demonstrated; the effect of phosphorus starvation appears to be relatively greater on the shoot system than on the root system.

Stimulation of Bark Renewal

Experiments on the effect of applications of palm oil on young renewing bark have been continued. The marked stimulation during the first year, previously reported, has been confirmed, but in the older experiments there are indications that the lead is not maintained: after two years the total thickness of renewed bark of the untreated control trees is not much less than that of the treated trees.

Treatment of Seeds with Growth-promoting Substances

Different proprietary preparations appear to have different effects with regard both to percentage survival and early growth, using Hevea seeds. No significant effect of growth-promoting substances on the percentage germination of cover-plant seeds was found, except that treatment at 50°C. proved effective with seed of *Centrosema pubescens* and *Pueraria javanica*.

V. Ecological Studies

This section gives an account of the observations on the different cover treatments on field 27 at the R.R.I. Experiment Station, which is in continuation of the results recorded in *Planting Manual* No. 6, (revised edition, page 28). Growth observations on the rubber trees on these plots show that the differences are not large. There is no significant difference between the growth of the trees on the plots planted with creeping leguminous covers and on those with controlled

natural covers. On the other hand, the trees on the plots with leguminous bush covers, and with natural covers with minimum control, show the poorest growth and differ significantly from the trees under the other three treatments. The seedling trees were test-tapped in January, thinned out in March and regular tapping was commenced in July. The yields for the first half year are recorded. The trees budded in the field in April 1935 were not large enough to bring into tapping in 1940. The yields of the sub plots planted with different types of clonal seed are also recorded.

VI. New Field Experiments at the R.R.I. Experiment Station

All the remaining reserve land, consisting of four sections of the area originally contained in the elephant belt, were planted. These areas will be used in 1941 for small-scale experiments.

VII. Field Experiments on Estates

Further experiments under the Experimental Planting provisions of the second restriction scheme were laid down. Experiments on five estates, comprising a total of 185 acres, were planted with estate seed preparatory to budding in the field for testing the later selections of R.R.I. clones. Three other estates were selected for experiments on soil problems, under the control of the Soils Division, to a total area of 150 acres.

With one exception all experiments, under the Experimental Planting scheme, which were planted with ordinary seed during the period 1936/38, have now been budded.

Weather Conditions

The results of experiments throughout the country under this scheme must be considered closely in reference to weather conditions. The distribution of rainfall in 1940 was abnormal. The first three months were exceptionally dry, and particularly in Kedah and Kelantan serious droughts were experienced. June and July were also abnormally dry in most districts. The latter part of the year was distinguished by exceptionally heavy downpours, causing serious floods in some places. Following on the two dry years of 1938 and 1939, the abnormal conditions in 1940 had the effect of retarding growth and development in young clearings, especially those budded late in 1939. The onset of heavy rain after a prolonged drought was partly responsible for the prevalence of bark-bursts, particularly in the coastal districts. A summary of meteorological observations forms an appendix to this report (see p. 18).

General observations on the growth characteristics, bark, etc., of the wide range of clones and clonal seedling families under test continued to be made. Amongst the proved clones, Glenshiel I is proving to have greater vigour on some inland soil types than was expected from earlier observations, and it seems to be a very suitable clone, with regard to secondary characters, for inland estates on more fertile soils as well as on estates in the coastal districts. Clones Pilmoor D.65 and B.D.5., are decidedly more backward. The former appeared to suffer probably more than any other clone from the exceptionally dry weather. Tjirandji 16 and P.B.86 both seem very susceptible to soil conditions, and it is preferable to confine their use to the more fertile soils. When buddings of Pilmoor B.84 reach the stage of heavy branching and rapid girthing, careful attention to pruning of superfluous branches is necessary.

The trials of clonal seedlings are well established, but they are not yet old enough for comparisons to be drawn between families or between the clonal

seedlings and their budded controls, but on the better soils the differences appear to be smaller than might be expected.

In the experiment comparing the value of budding in the field with planting of budded stumps and stumped buddings, all preparatory work has now been completed and very valuable results are expected in the future. In other experiments comparing budded stumps with seedlings budded in the field, measurements taken three years after planting show that the mean girth of the buddings made in the field is only the equivalent of three months growth less than that of the budded stumps planted at the same time as the seed. This is much less than the advantage for budded-stump planting which is often claimed, in spite of the fact that the conditions under which the above results were obtained are such as are generally regarded as the most favourable for budded stumps.

In the experiments where catch-crops are grown in young rubber plantations, the retardation of the growth of the rubber trees where a crop of tapioca was taken, has become less marked. Derris forms an excellent soil cover, and these experiments will give useful information regarding its tolerance of shade.

PESTS AND DISEASES

The headings in this summary are the same as those in the Report of the Pathological Division (see page 18).

I. Root Diseases

The control of root disease in connection with replanting continues to be the chief problem investigated. One new experiment was started of which details are given. The further results of the experiments already in progress are discussed in some detail, with reference to both their technical and their economic aspects. It is sufficient here to state the main practical conclusions derived from the results.

The new results obtained in 1940 have made it necessary to modify our practical recommendations in connection with replanting.

For dealing with root-disease patches in the old stand, it is now evident that it is unnecessary to dig over the open central areas of such patches. Diseased roots of *known* infected trees should be removed, but further digging is uneconomic, except to follow up further sources of infection revealed in the course of filling and holing. This may now be accepted as a general recommendation both on inland and coastal soils. It should be added that where root-disease patches are being cleaned up in mature areas which are *not* to be replanted for some considerable time, greater care must be taken over the eradication of infected roots. If the patches are to be supplied the centres need not be dug over, but annular zones at least 25 feet wide must be carefully cleaned up around the margins if reinfection of the surrounding mature trees is to be avoided. Small patches which are not to be supplied should be completely dug over.

For controlling the incidence of root disease in areas where there was no obvious evidence thereof in the old stand, poisoning by either the frill-girdling or stump-poisoning technique appears to be a cheap and successful method of clearing healthy trees, which can safely be recommended in any area where the incidence of *Fomes lignosus* after replanting is known to be low. It is especially suitable for use on steeply sloping ground, where soil disturbance must be reduced to a minimum. Care should be exercised, however, in using the method in any area where the activity of *Fomes lignosus* after replanting is likely to be high. This warning applies particularly to coastal soils. In doubtful cases normal felling is the best alternative.

The choice between poisoning by frill-girdling and stump-poisoning depends on circumstances. The latter is a little cheaper, but has the disadvantage that it must be carried out 3 months at least before felling, with consequent loss of crop.

The cheapest clearing method of all is to poison by frill-girdling and allow the poisoned trees to decay in situ. In this way felling is entirely avoided, and the old trees can be tapped right up to the time of planting, and even later if so desired. The crowns of the trees rot and fall down piecemeal and the damage caused to the young stand is surprisingly small, but the method carries a risk to human life which cannot be disregarded. The method has not been included in any of the replanting experiments described above as such experiments have to be carried out on outside estates where we cannot be expected to accept responsibility for this risk. It has been tested, however, at the Experiment Station as a method of clearing jungle trees for new planting (see *Annual Report* for 1939 (Botanical Division) p. 147).

In connection with poisoning treatments, there appears to be a widespread misconception. Poisoning will *not* kill the root-disease fungus in infected roots, and it is of no value as a means of lessening their danger as sources of infection. But poisoning *does* kill healthy roots, and since the spread of root-disease fungi through the soil is brought about only by *live* roots, not dead ones, poisoning can be very effective in lessening the *spread* of root-disease.

II. Above-ground Diseases

Tapping Panel Diseases

Two preparation were tested and approved for the control of Mouldy Rot, and four were rejected.

Cases of Black Stripe and Patch Canker were investigated, also sunscorch of the tapping panel which was more prevalent than usual as a result of the abnormal drought. Palm oil treatment may prove to be a good palliative.

Investigations on the possible relation of bacterial infection to brown bast were carried out.

Stem and Branch Diseases

Pink disease occurred fairly extensively in some districts, in the wet period of the year. A proposal to use flame scorching as a method of treatment is under investigation, but cannot yet be recommended.

Spearhead dieback of buddings was also more prevalent than usual as a result of the dry weather.

Further cases of bark-bursts, to which certain clones appear to be rather prone, have been investigated, and methods of treatment are being studied.

Leaf Diseases

Weather conditions early in the year were practically ideal for rapid wintering and refoliation, with the result that Oidium leaf mildew was practically nonexistent; it was reported from only 31 estates.

The position regarding minor leaf disease was similar to that reported for 1939.

III. Insect and Animal Pests

Cockchafer Pest

Work on the distribution, life history and control of the various species concerned has been actively continued. It has now been definitely established that *Psilopholis* occurs only on estates close to primary forest, and only in areas of mature rubber trees thereon. But much cockchafer-grub damage results from other species, notably species of *Leucopholis, Lepidiota, Lachnosterna* and *Exopholis*, which are

essentially inhabitants of secondary forest and in some cases possibly of grass lands. The damage to rubber plantations by these species is almost wholly confined to young plants on newly cleared areas, from the grubs already in the soil before clearing. Once these have pupated, the trouble is usually over, though with certain species (*Leucopholis and Lepidiota*) the pest may sometimes persist and cause damage in mature areas, similar to that caused by *Psilopholis*.

Psilopholis is confined to a few areas; fortunately, and so far inexplicably, it shows no signs of spreading to other areas of similar soil, topography, and proximity to jungle. The harm done to the productivity of rubber areas by this species is almost wholly caused indirectly by impairment of soil conditions, through destruction of ground cover and promotion of erosion. Soil fumigation with a larvicide, which need not aim at a complete kill, but merely at a certain reduction in grub-density, is effective, but expensive. Carbon bisulphide is still the best fumigant, in spite of its secondary disadvantages, but at present it is unobtainable, even in amounts enough for experimental purposes. A satisfactory kill has been obtained with petrol, but as the effective rate of application was 172 gallons per acre, this method is not feasible under present conditions.

Since the trouble with the species other than *Psilopholis*, mentioned above, is usually only a passing one, it appears sufficient to protect the young plants in their first year, until the grubs pupate and the pest disappears from the area. This can probably be done by the use of repellants such as naphthalene and paradichlorbenzene, but experimental work has been held up owing to difficulties of obtaining supplies.

Termites ("White Ants")

The "white ant" problem is complex and though considerable progress has been made with the treatment of attacked trees the biology and ecology of the pest are still very imperfectly understood. Until these fundamental points have been studied permanent control of the pest is not possible.

Several species are present in rubber plantations and although these are very similar to each other important difference in their habits are coming to light. Previous workers did not appreciate these distinctions so some of the information they obtained loses its value.

Control methods for white ants may be summarised as follows:—

(1) Ecological, that is by attention to the surroundings. This consists of the discovery and destruction of nests and the removal of stumps and logs harbouring "white ants." It is useless to destroy the easily-obtained queens of the wrong kind of termite and it also seems probable that the *Coptotermes* which attacks living trees is not the same as the *Coptotermes* usually found in dead wood. Therefore great care is necessary and as this method is very expensive further study is required before it can be recommended.

(2) Treatment of attacked trees with an insecticide. This method has been very fully dealt with in *Annual Report* 1939. Using mercury perchloride successful control can be obtained but the method has two disadvantages. First the poison does not reach the nest so there is a strong tendency for fresh trees to become infested. Secondly in cases of subterranean attack the plant is often beyond help before the attack becomes apparent.

(3) Treatment of all trees with a repellent. In order to overcome the difficulty of driving the termites from tree to tree and also to obviate the necessity for waiting until signs of damage become apparent, the application of repellent substances is being tried. An ideal repellent should be effective against the pest; harmless to the tree; durable in the soil; cheap to buy and easy to obtain. It might even be possible to combine an insecticide and repellent and it is thought

that such treatment would prove very useful in new plantings both against termites and cockchafer grubs. Trials of suitable material have been held up by the difficulties of getting the necessary chemicals. Both naphthalene and paradichlorbenzene have been found promising. Experiments designed to ascertain suitable dosages, the effect on plant growth, and durability in the soil are in progress, but it has not yet been possible to test the direct insecticidal or repellent value of these chemicals against either termites or cockchafer grubs in the field.

Other Insect and Animal Pests

Rodent damage is commonly ascribed to rats. Squirrels are often, and perhaps much more often, the culprits. It is possible, by observations on lines detailed in the Report, to decide what type of animal is actually responsible and what method to use to control it.

Besides rats and squirrels, other pests sometimes causing damage are monkeys, mouse deer, grasshoppers, "lady birds," various kinds of caterpillars, eelworms, snails and slugs. Most of these attack cover plants chiefly. Descriptions of such pests, the damage they cause, and control methods are given in the Report.

IV. Bacteriology

Soil Bacteriology. Nodule Bacteria

Tubes of cultures of Rhizobium, the nodule bacteria of leguminous cover plants, were distributed to the number of 598, mostly for *Centrosema* and *Pueraria*.

Work on the isolation and testing of new strains, and the rejuvenation of old strains, was continued.

Observations from pot experiments with rubber seedlings and covers showed a marked retardation of growth of the trees by the presence of inoculated *Centrosema*; in some pots, although the *Centrosema* was prevented from climbing up the rubber plants, the growth of the latter was almost completely inhibited. It must, of course, be realised that the conditions of competition in pot cultures are very much more severe than in the field.

Latex Bacteriology

An apparatus for collecting latex from the tree under aseptic conditions has been devised and used. Samples of latex of varying bacterial content were obtained; two samples were sterile. Observations of coagulation in relation to bacterial content were made. From the fact that the sterile samples coagulated within 24 hours and without appreciable change in acidity, it is clear that although bacterial action no doubt plays its part in natural coagulation, it is not essential thereto.

CHEMICAL AND TECHNOLOGICAL PROBLEMS

The work of the Chemical Division is here summarised under the same headings as those used in the Report of that Division (see page 18).

I. Latex

Chemistry & Technology of Latex

Investigations have been made on the influence of storage and other factors on the acid-value of latex. Acid formation appears to be mainly a result of the action of bacterial enzymes, which can be inactivated by heating or other means, or the production of which can be prevented by the sterilising effect of preservation with ammonia.

Further work on the "caoutchol" fraction of rubber has been carried out in association with the British Rubber Producers' Research Association. The "oxide fraction" of Bloomfield and Farmer seems closely to resemble the "caoutchol" fraction of Roberts.

Revised arrangements have been introduced for testing latex for estates.

Further work has been carried out on films for coating the inside of latex drums, to avoid discolouration.

A further number of possible latex preservatives have been tested, mostly without success. However, guiacol may be mentioned as showing promise, and other lines are also being followed up. Bacterial counts are of importance in the study of preservation problems, and the Pathological Division has collaborated with the Chemical Division in these. The value of Santobrite (sodium pentachlorphenate) as a preservative is now well proven, used in association with small amounts of ammonia.

Urea may be used, at a strength of about 0.5 per cent, as a substitute for ammonia when used in conjunction with Santobrite.

The proposal to preserve latex by autoclaving in presence of a buffer solution has been investigated and rejected as of no practical value.

Latex Concentration

The cutting-off of the German, Danish and Swedish markets has made difficult the purchase of centrifugal machines of proved efficiency, American-made machines being much more expensive and subject to import restrictions. A machine of English manufacture was tested. A paper was published on the centrifugal concentration of latex giving details of the performance of various machines, and reviewing the practical aspects of centrifuging on estates.

The falling-off of the latex market, however, rendered these difficulties of less practical importance for the time being, though they threatened to become onerous again as the latex market showed signs of reviving at the end of the year. Assistance was given to several estates in designing and starting centrifuge installations.

With the higher rate of export release the value of the rubber remaining in centrifuge skim—about 6 to 8 per cent—became of greater moment, and has stimulated work on improved methods of recovery. Crepe made from centrifuge skim is difficult to distinguish with certainty from some lower grades of normal crepe, though markedly different in processing properties. Work was therefore put in hand for finding simple means of identifying skim-crepe.

Concentration of latex by creaming was reviewed in a paper which will be published in the *Journal*. Further work has been carried out on the mechanism of creaming, and tests of preparations of methyl cellulose as a creaming agent were made.

II. Technological Studies of Rubber

The report of the Crude Rubber Committee of the American Chemical Society, with reference to standard methods of sampling and testing, and the variability of raw rubber, is discussed in relation to our experience and data.

Studies of variability have been continued. Variations in the rubber from day to day on a given estate are less than the variations from one estate to another. Rubber from young trees is more variable than that from old trees. The nature of the tapping system is an important factor in variability; there are marked differences in the physical and vulcanisation properties of sheet rubber according to the tapping system used.

The previously recorded marked difference in plasticity between the rubbers from Clones Tj. 1 and P.B. 186 has been confirmed, and has been found to occur regardless of the locality where the buddings are growing. It is, thus, an inherent characteristic difference between the clones. The study of plasticity variations in the rubber from individual trees is being continued.

III. Modified Rubber

The work on low water-absorption rubber has been continued and the process of manufacture adapted for use on the commercial scale. Several large samples have been sent to England and to the U.S.A. for trial by manufacturers, and reports so far received are very favourable. A suitable standard technique for determination of water-absorption by rubber has been worked out.

In development of the work on the production of softened rubber by the use of peptising agents added to the latex, applications for patents for three processes have been made, and a local planting company has started the commercial manufacture of softened rubber by one of these processes.

IV. Estate Supplies

The shortage of formic acid at the end of 1939 was relieved by the arrival of adequate supplies of acetic acid in 1940. The marketing of coagulants containing sulphuric acid was checked by the imposition of import control for this acid. There was a considerable increase in the number of samples of coagulants received for analysis. Various possible local sources of coagulants were investigated, such as fermented vegetable materials (*e.g.* pineapple, coconut water, toddy), tamarind extract, pyroligneous acid from charcoal kilns and coconut shells. In the absence of feasible methods of concentration, such coagulants can be used only locally, owing to high transport costs of such dilute acids.

The use of serum for coagulation (see *Annual Report* 1939 page 210) formed the subject of a paper in the *Journal*.

The cutting-off of supplies from Scandinavia caused considerable difficulties in the supply of plywood cases. Samples of plywood from Canada, Japan, China and Australia were examined. Good locally-made plywood was found to compare favourably with the imported product.

Alternatives to paranitrophenol for mould prevention, and sodium sulphite as an anti-coagulant, have been investigated.

Supplies of aluminium and of metal gauze have been uncertain, and the Institute has been consulted by trade interests and by the control authorities.

V. Estate Technique

The R.R.I. Tunnel Smoke house has been widely adopted in Malaya, and has also been introduced into Burma, Ceylon and North Borneo. Modifications in design are being studied, in the light of experience on estates. A new design (type C) of larger size has been worked out.

A scrap-drying shed has been designed and is being tested.

The packing of rubber in "bare-back" bales has been the subject of considerable work. An impetus to this subject has been given by the shortage of cases. Our experiments have proved that this type of packing can be carried out cheaply on estates without the need for special equipment. Trial shipments to England and America have been made.

Sample bales wrapped in a proprietary reinforced paper have been prepared and sent to England for report.

A study is being made of estate practice in the matter of methods for avoiding the presence of sand and grit in smoked sheet, and improvements in such methods are being investigated.

THE WORK OF THE SCIENTIFIC STAFF OF THE LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON & MALAYA)

The Report of the Chemical Division should be read in conjunction with the Report of the above Committee (see p. 18). In the Technical Appendix to that report there is an account of the investigation carried out by the scientific staff to the Committee, which are summarised as follows:—

As a result of the investigations on latex a comprehensive picture of its structure is being systematically developed—attention being given not only to the nature of the substances present, but also to their situation and arrangement with respect to their physical relationships. The functions of different groups of substances and the factors determining quality are in consequence becoming more clearly defined. The information so far obtained is incomplete and the investigations are being continued, but the prospects of developing rational and practical tests for quality are definitely improved.

Preliminary work on the fractionation of rubber, ultimately connected with the possibility of obtaining different rubber hydrocarbons by selective propagation, has been in progress for some time and is leading to conclusions somewhat different from those obtained by other investigators. The results suggest that rubber contains a mixture of hydrocarbons which differ not so much in solubility as in rate of solution and that non-rubber substances can have marked effects on the rate of solution without necessarily affecting the size or chemical identity of the rubber hydrocarbon. Normal methods of testing may therefore yield misleading results concerning difference between hydrocarbon fractions and the possibility of devising a reliable test is under consideration.

In connection with the preparation on a large scale of clean and uniform rubber, attention has been given to the inconstancy of the same method of test carried out in different laboratories. It has not been found possible to eliminate all the discrepancies, but the problem is still under investigation, and there are several ways in which the difficulties may be overcome.

Manufacturers have displayed considerable interest in clean rubber and also in softened rubber prepared by a method devised by the staff of the Rubber Research Institute, Malaya and large scale trials have been arranged.

EXPERIMENT STATION

The following is a brief summary of the Report, under the same headings as those used therein (see p. 18).

Acreage and Distribution of Land

At the 31st December 1940 the area planted was 1,228 acres, of which 812 acres were in bearing. Three-quarters of the planted area is devoted to Botanical Division experiments, and most of the remainder consists of Soils Division experiments, leaving 50 acres for the Pathological and Chemical Divisions.

Botanical Division Areas

Particulars are given of new clearings (including costs), nurseries, and of the progress of the experiments described in previous Reports and discussed in the reports of Divisions. A total of nearly 10,000 yards of budwood and 7,000 seeds were despatched to experimental areas on various estates, as well as 3,900 yards of budwood of the new R.R.I. 500 series clones.

Soils Division Areas

The progress of the manuring and other experiments in various fields is recorded. Experimental work was carried out on composting; a mixture of oil-palm-bunch refuse and Mikania cuttings was found to give satisfactory results. Thirty-five tons of compost were made and used in nurseries.

Pathological Division

This Division was responsible for routine inspection and treatment throughout all fields. Altogether over 8,000 trees were treated, more than half for termites. Sulphur dusting was carried out against thrips. An experimental garden for the Entomologist was established.

Chemical Division

Samples of sheet and latex were taken and sent to the Division, and special experiments in connection with factory technique were conducted. Bare-back baling experiments were carried out.

Routine and General

Manuring in most mature areas is now biennial.

Fifty-five chains of new road were constructed. Further new lines for the labour force, and other buildings, were erected.

The total amount of rubber despatched for sale was 524,474 lb., and in addition nearly 18,000 lb. were sent to headquarters for experimental purposes.

The total rainfall for the year was 95.15 inches, of which 40 inches fell in the last quarter, and only 21 in the four months June/September.

The labour force totalled 342, with 158 dependants.

Nine refresher courses, for 45 estate conductors, were held.

The number of visitors, at 311, was much less than normal.

Staff

It is with the deepest regret that the death of the Manager, Mr. T. N. Dickson, on the 7th October 1940, is recorded.

IMPORTANT NOTICE

The full Annual Report is being sent to all on the Subscription, Exchange and Complimentary mailing lists, who therefore need not use the form on the inside back cover.

ALL THOSE ON THE FREE MAILING LIST who wish to receive any of the full Reports, or Sections thereof, must complete the form on the last page, and send it so as to reach the Rubber Research Institute not later than the 30th November, 1941.

Place a cross against each of the separate items numbered 1 to 18 in the list, which you wish to receive, sign it, and fill in your name and address clearly in the address label, **which will be used as the address label on the postage wrapper.**

ABRIDGED ANNUAL REPORT FOR 1940

The following is the table of contents of the *full* Report, of which the Report by the Director (without Appendices) is here issued as the Abridged Report:—

Report of the Board

Accounts

Report of the Director

Appendices to Report of the Director

Report on the work of the Soils Division

" " " " " " Botanical Division

" " " " " " Pathological Division

" " " " " " Chemical Division

" " " " " " Experiment Station

" " " " " " Small Holders' Advisory Service

Report of The London Advisory Committee for Rubber Research (Ceylon and Malaya).

IMPORTANT NOTICE

Those wishing to receive any of the above full Reports must refer to the notice at the end of the Abridged Report.

		Mark with a X
1.	Report of the Board	
2.	Accounts	
3.	Appendices to the Report by the Director	
4.	Soils Division Report	
5.	Botanical Division Report. I. Vegetative Propagation ...	
6.	„ „ „ II. Tapping Investigations ...	
7.	„ „ „ III. Selection and Breeding ...	
8.	„ „ „ IV. Physiological Investigations; V. Ecological Studies; VI. New Field Experiments on the R.R.I. Experiment Station; VII. Field Experiments on Estates; VIII. Advisory Work, Staff, etc.	
9.	Pathological Division Report. I. Root Disease Investigations	
10.	„ „ „ II. Above-ground Diseases ...	
11.	„ „ „ III. Insect and Animal Pests ...	
12.	„ „ „ IV. Bacteriology ... ... V. Advisory Work, Staff etc.	
13.	Chemical Division Report. I. Latex	
14.	„ „ „ II. Technological Studies of Rubber	
15.	„ „ „ III. Modified Rubber; ... „ „ „ IV. Estate Supplies; ... „ „ „ V. Estate Technique; ... „ „ „ VI. Advisory Work, Staff etc. ...	
16.	Report on the Work of the Experiment Station	
17.	Report on the Work of the Small-Holders' Advisory Service	
18.	Report of The London Advisory Committee	
	Date..... Signature.....	

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